

## CLAIMS

1. A method of judging deterioration of a battery that supplies electric power to a load comprising the steps of:

5        comparing a minimum guaranteed voltage predetermined as a minimum value of a terminal voltage of the battery when a given current flows into the load, with a first difference value, which is obtained by subtracting a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred during a discharge of the battery from  
10    an open circuit voltage that corresponds to a state of charge upon a start of the discharge of the battery in response to the discharge of the battery with the given current; and

      judging the deterioration of the battery on the basis of a result of the comparison.

15 2. A method of judging deterioration of a battery that supplies electric power to a load comprising the steps of:

      comparing a minimum guaranteed voltage predetermined as a minimum value of a terminal voltage of the battery when a given current flows into the load, with a first difference value, which is obtained by  
20    subtracting a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred during a discharge of the battery from an open circuit voltage that corresponds to a state of charge upon a start of the discharge of the battery in response to the discharge of the battery with the given current; and

25        judging that the battery is deteriorated if the first difference value becomes equal to or smaller than the minimum guaranteed voltage and

the state of charge upon the start of the discharge exceeds a first specific value.

3. A method of judging deterioration of a battery that supplies electric power to a load comprising the steps of:

5        comparing a minimum guaranteed voltage predetermined as a minimum value of a terminal voltage of the battery when a given current flows into the load, with a first difference value, which is obtained by subtracting a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred during a discharge of the battery from  
10    an open circuit voltage that corresponds to a state of charge upon a start of the discharge of the battery in response to the discharge of the battery with the given current;

      if the first difference value becomes equal to or smaller than the minimum guaranteed voltage and the state of charge upon the start of the  
15    discharge is equal to or smaller than a first specific value, converting the state of charge that is equal to or smaller than the first specific value into a state of charge of the first specific value;

      comparing the minimum guaranteed voltage with a second difference value, which is obtained by subtracting the voltage drop from  
20    an open circuit voltage that corresponds to the converted state of charge of the first specific value; and

      judging that the battery is deteriorated if the second difference value is equal to or smaller than the minimum guaranteed voltage.

4. A method of judging deterioration of a battery that supplies electric  
25    power to a load comprising the steps of:

      comparing a minimum guaranteed dischargeable capacity

predetermined for supplying an electrical quantity required at the minimum to the load for a specific period of time when a given current flows into the load, with a first estimated dischargeable capacity estimated on the basis of a first difference value, which is obtained by subtracting a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred during a discharge of the battery from an open circuit voltage that corresponds to a state of charge upon a start of the discharge of the battery in response to the discharge of the battery with the given current; and

judging the deterioration of the battery on the basis of a result of the comparison.

5. A method of judging deterioration of a battery that supplies electric power to a load comprising the steps of:

comparing a minimum guaranteed dischargeable capacity predetermined for supplying an electrical quantity required at the minimum to the load for a specific period of time when a given current flows into the load, with a first estimated dischargeable capacity estimated on the basis of a first difference value, which is obtained by subtracting a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred during a discharge of the battery from an open circuit voltage that corresponds to a state of charge upon a start of the discharge of the battery in response to the discharge of the battery with the given current; and

judging that the battery is deteriorated if the first estimated dischargeable capacity becomes equal to or smaller than the minimum guaranteed dischargeable capacity and the state of charge upon the start

of the discharge exceeds a first specific value.

6. A method of judging deterioration of a battery that supplies electric power to a load comprising the steps of:

comparing a minimum guaranteed dischargeable capacity  
5 predetermined for supplying an electrical quantity required at the minimum to the load for a specific period of time when a given current flows into the load, with a first estimated dischargeable capacity estimated on the basis of a first difference value, which is obtained by subtracting a voltage drop due to an ohmic resistance and polarization  
10 resistance of the battery occurred during a discharge of the battery from an open circuit voltage that corresponds to a state of charge upon a start of the discharge of the battery in response to the discharge of the battery with the given current;

if the first estimated dischargeable capacity becomes equal to or  
15 smaller than the minimum guaranteed dischargeable capacity and the state of charge upon the start of the discharge is equal to or smaller than a first specific value, converting the state of charge that is equal to or smaller than the first specific value into a state of charge of the first specific value;

20 comparing the minimum guaranteed dischargeable capacity with a second estimated dischargeable capacity, which is estimated for the converted state of charge of the first specific value; and

judging that the battery is deteriorated if the second estimated dischargeable capacity is equal to or smaller than the minimum  
25 guaranteed dischargeable capacity.

7. A method of judging deterioration of a battery that supplies electric

power to a load comprising the steps of:

comparing a summed value of (a) a minimum guaranteed dischargeable capacity predetermined for supplying an electrical quantity required at the minimum to the load for a specific period of time when a  
5 given current flows into the load and (b) an error in detecting the dischargeable capacity, with a first estimated dischargeable capacity estimated on the basis of a first difference value, which is obtained by subtracting a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred during a discharge of the battery from  
10 an open circuit voltage that corresponds to a state of charge upon a start of the discharge of the battery in response to the discharge of the battery with the given current; and

judging the deterioration of the battery on the basis of a result of the comparison.

15 8. A method of judging deterioration of a battery that supplies electric power to a load comprising the steps of:

comparing a summed value of (a) a minimum guaranteed dischargeable capacity predetermined for supplying an electrical quantity required at the minimum to the load for a specific period of time when a  
20 given current flows into the load and (b) an error in detecting the dischargeable capacity, with a first estimated dischargeable capacity estimated on the basis of a first difference value, which is obtained by subtracting a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred during a discharge of the battery from  
25 an open circuit voltage that corresponds to a state of charge upon a start of the discharge of the battery in response to the discharge of the battery

with the given current; and

judging that the battery is deteriorated if the first estimated dischargeable capacity becomes equal to or smaller than the summed value and the state of charge upon the start of the discharge exceeds a first specific value.

9. A method of judging deterioration of a battery that supplies electric power to a load comprising the steps of:-

comparing a summed value of (a) a minimum guaranteed dischargeable capacity predetermined for supplying an electrical quantity required at the minimum to the load for a specific period of time when a given current flows into the load and (b) an error in detecting the dischargeable capacity, with a first estimated dischargeable capacity estimated on the basis of a first difference value, which is obtained by subtracting a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred during a discharge of the battery from an open circuit voltage that corresponds to a state of charge upon a start of the discharge of the battery in response to the discharge of the battery with the given current;

if the first estimated dischargeable capacity becomes equal to or smaller than the summed value and the state of charge upon the start of the discharge is equal to or smaller than a first specific value, converting the state of charge that is equal to or smaller than the first specific value into a state of charge of the first specific value;

comparing the minimum guaranteed dischargeable capacity with a second estimated dischargeable capacity, which is estimated for the converted state of charge of the first specific value; and



judging that the battery is deteriorated if the second estimated dischargeable capacity is equal to or smaller than the summed value.

10. The method of judging deterioration of a battery as claimed in any one of claims 1 – 9, wherein the battery is judged deteriorated if the state  
5 of charge of the battery becomes equal to or smaller than a second specific value that is set lower than the first specific value.

11. The method of judging deterioration of a battery according to 2, 3, 5, 6, 8, 9 or 10, wherein when the battery is judged deteriorated, a display for warning deterioration of the battery is carried out.

10 12. An apparatus for judging deterioration of a battery that supplies electric power to a load comprising:

storing means for storing a minimum guaranteed voltage predetermined as a minimum value of a terminal voltage of the battery when a given current flows into the load;

15 voltage drop computing means for computing a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred in response to a discharge of the battery when a given current flows from the battery into the load;

first comparing means for comparing the minimum guaranteed  
20 voltage stored in the storing means with a first difference value, which is obtained by subtracting the voltage drop computed by the voltage drop computing means from an open circuit voltage that corresponds to a state of charge upon a start of the discharge of the battery; and

first deterioration judging means for judging that the battery is  
25 deteriorated if the first difference value becomes equal to or smaller than the minimum guaranteed voltage and the state of charge upon the start of

the discharge exceeds a first specific value as a result of the comparison by the first comparing means.

13. An apparatus for judging deterioration of a battery that supplies electric power to a load comprising:

5 storing means for storing a minimum guaranteed voltage predetermined as a minimum value of a terminal voltage of the battery when a given current flows into the load;

voltage drop computing means for computing a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred in  
10 response to a discharge of the battery when a given current flows from the battery into the load;

first comparing means for comparing the minimum guaranteed voltage stored in the storing means with a first difference value, which is obtained by subtracting the voltage drop computed by the voltage drop  
15 computing means from an open circuit voltage that corresponds to a state of charge upon a start of the discharge of the battery;

conversion means for converting a state of charge that is equal to or smaller than the first specific value into a state of charge of the first specific value, if the first difference value becomes equal to or smaller  
20 than the minimum guaranteed voltage and the state of charge upon the start of the discharge is equal to or smaller than a first specific value as a result of the comparison by the first comparing means;

second comparing means for comparing the minimum guaranteed voltage with a second difference value, which is obtained by subtracting  
25 the voltage drop from an open circuit voltage that corresponds to the state of charge of the first specific value converted by the conversion



means; and

first deterioration judging means for judging that the battery is deteriorated if the second difference value is equal to or smaller than the minimum guaranteed voltage.

- 5 14. An apparatus for judging deterioration of a battery that supplies electric power to a load comprising:

storing means for storing a minimum guaranteed dischargeable capacity predetermined for supplying an electrical quantity required at the minimum to the load for a specific period of time when a given  
10 current flows into the load,

voltage drop computing means for computing a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred in response to a discharge of the battery when a given current flows from the battery into the load;

15 third comparing means for comparing the minimum guaranteed dischargeable capacity stored by the storing means with a first estimated dischargeable capacity estimated on the basis of a first difference value, which is obtained by subtracting a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred during a  
20 discharge of the battery from an open circuit voltage that corresponds to a state of charge upon a start of the discharge of the battery in response to the discharge of the battery with the given current; and

first deterioration judging means for judging that the battery is deteriorated if the first estimated dischargeable capacity becomes equal  
25 to or smaller than the minimum guaranteed dischargeable capacity and the state of charge upon the start of the discharge exceeds a first specific

value as a result of the comparison by the third comparing means.

15. An apparatus for judging deterioration of a battery that supplies electric power to a load comprising:

storing means for storing a minimum guaranteed dischargeable  
5 capacity predetermined for supplying an electrical quantity required at the minimum to the load for a specific period of time when a given current flows into the load,

voltage drop computing means for computing a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred in  
10 response to a discharge of the battery when a given current flows from the battery into the load;

third comparing means for comparing the minimum guaranteed dischargeable capacity stored by the storing means with a first estimated dischargeable capacity estimated on the basis of a first difference value,  
15 which is obtained by subtracting a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred during a discharge of the battery from an open circuit voltage that corresponds to a state of charge upon a start of the discharge of the battery in response to the discharge of the battery with the given current;

20 conversion means for converting a state of charge that is equal to or smaller than the first specific value into a state of charge of the first specific value, if the first estimated dischargeable capacity becomes equal to or smaller than the minimum guaranteed dischargeable capacity and the state of charge upon the start of the discharge exceeds a first  
25 specific value as a result of the comparison by the third comparing means;

fourth comparing means for comparing the minimum guaranteed dischargeable capacity with a second estimated dischargeable capacity, which is estimated for the state of charge of the first specific value converted by the conversion means; and

5 first deterioration judging means for judging that the battery is deteriorated if the second estimated dischargeable capacity is equal to or smaller than the minimum guaranteed dischargeable capacity.

16. An apparatus for judging deterioration of a battery that supplies electric power to a load comprising:

10 storing means for storing (a) a minimum guaranteed dischargeable capacity predetermined for supplying an electrical quantity required at the minimum to the load for a specific period of time when a given current flows into the load and (b) an error in detecting the dischargeable capacity;

15 voltage drop computing means for computing a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred in response to a discharge of the battery when a given current flows from the battery into the load;

20 third comparing means for comparing a summed value of (a) the minimum guaranteed dischargeable capacity stored in the storing means and (b) the error in detecting the dischargeable capacity, with a first estimated dischargeable capacity estimated on the basis of a first difference value, which is obtained by subtracting a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred  
25 during a discharge of the battery from an open circuit voltage that corresponds to a state of charge upon a start of the discharge of the

battery in response to the discharge of the battery with the given current;  
and

first deterioration judging means for judging that the battery is deteriorated if the first estimated dischargeable capacity becomes equal  
5 to or smaller than the summed value and the state of charge upon the start of the discharge exceeds a first specific value as a result of the comparison by the third comparing means.

17. An apparatus for judging deterioration of a battery that supplies electric power to a load comprising:

10 storing means for storing (a) a minimum guaranteed dischargeable capacity predetermined for supplying an electrical quantity required at the minimum to the load for a specific period of time when a given current flows into the load and (b) an error in detecting the dischargeable capacity;

15 voltage drop computing means for computing a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred in response to a discharge of the battery when a given current flows from the battery into the load;

third comparing means for comparing the minimum guaranteed  
20 dischargeable capacity stored by the storing means with a first estimated dischargeable capacity estimated on the basis of a first difference value, which is obtained by subtracting a voltage drop due to an ohmic resistance and polarization resistance of the battery occurred during a discharge of the battery from an open circuit voltage that corresponds to  
25 a state of charge upon a start of the discharge of the battery in response to the discharge of the battery with the given current;

conversion means for converting a state of charge that is equal to or smaller than a first specific value into a state of charge of the first specific value, if the first estimated dischargeable capacity becomes equal to or smaller than a summed value of (a) the minimum guaranteed dischargeable capacity and (b) the error in detecting the dischargeable capacity stored in the storing means and the state of charge upon the start of the discharge is equal to or smaller than a first specific value as a result of the comparison by the third comparing means;

fourth comparing means for comparing the minimum guaranteed dischargeable capacity with a second estimated dischargeable capacity, which is estimated for the state of charge of the first specific value converted by the conversion means; and

first deterioration judging means for judging that the battery is deteriorated if the second estimated dischargeable capacity is equal to or smaller than the summed value.

18. The apparatus for judging deterioration of a battery as claimed in any one of claims 12 – 17, further comprising second deterioration judging means for judging that the battery is deteriorated if the state of charge of the battery becomes equal to or smaller than a second specific value that is set lower than the first specific value.

19. The apparatus for judging deterioration of a battery as claimed in any one of claims 12 – 18, further comprising warning display means for carrying out a display for warning deterioration of the battery when the battery is judged deteriorated.